§39. High Heat Flux Tests of Mechanical Jointed Module for Divertor Plates of LHD

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In order to prepare highly reliable, effective and low cost divertor plates, which are used in the startup experimental phase of LHD, a full scale mechanical jointed module(FS-MJM) has been fabricated and evaluated for thermal properties. The module consists of a graphite tile, backing copper plate, stainless steel(SUS) plate, and a cooling pipe as shown in Fig.1. Thin carbon sheets

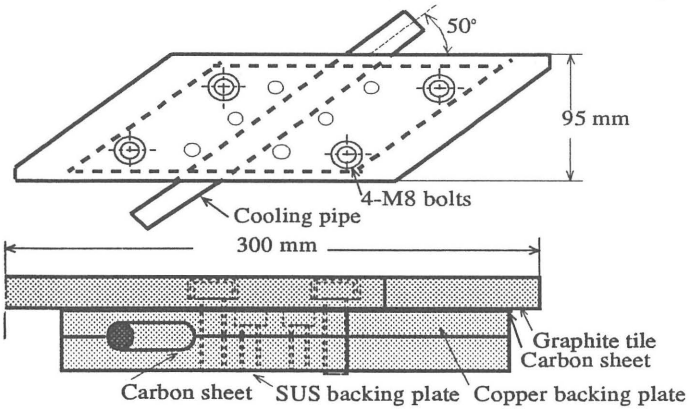

Fig.1 Structure of a FS-MJM fabricated and tested.

are used as a compliant sheet at the interfaces between the backing plate and cooling pipe and between the tile and backing plate to improve the thermal contacts. The cooling pipe is strongly hold with two copper and SUS backing plates using six bolts. The graphite tile is also fixed with the SUS backing plate using four bolts. To evaluate the effect of cooling pipe on the thermal response of the module, the different materials and thicknesses for the pipe were used. Steady high heat fluxes tests up to 1.75MW/m^2 have been carried out using a test facility called ACT[1].

Fig.2 shows typical thermal responses of the module with a copper backing plate and a SUS cooling pipe of 27.2mm in dia. and 1.2mm in thickness under a steady heat fluxes of 0.75 MW/m^2. The figure indicates the responses of temperatures(Ts,Tu,Tl) at the upper tile, lower tile, and copper backing plate. As shown in the figure, each response saturates with the elapsed time. The temperature(Tl) of the backing plate is lower than

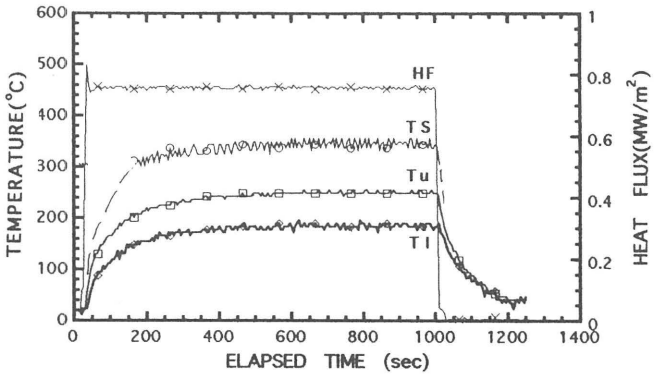

Fig.2 Typical thermal responses of FS-MJM under a steady heat flux of 0.75 MW/m^2.

200°C at the end of the heat load test. As the heat flux increases, the temperature(Tl) increases near linearly. However, when Tl exceeds about 250°C under higher heat fluxes, the temperature shows not a saturated response but unsaturated one due to the change of thermal property. The relationship between the temperature of the backing plate at the end of the test and heat flux is plotted as shown in Fig.3. In the figure, OFC, DSC, and NEC represent the material of the backing plate, oxygen free copper, DS copper, and normal copper, respectively. SUS or Cu after the slash sign shows the material of the cooling pipe. The thickness of the cooling pipe used is 1.2mm or 2.5mm(for only #1). The figure shows that the effect of material and thickness of the cooling pipe on the thermal property of the module is very large. The compatibility with the thermal property, mechanical safety, cost, and maintenance must be well considered for the application to divertor plates of LHD.

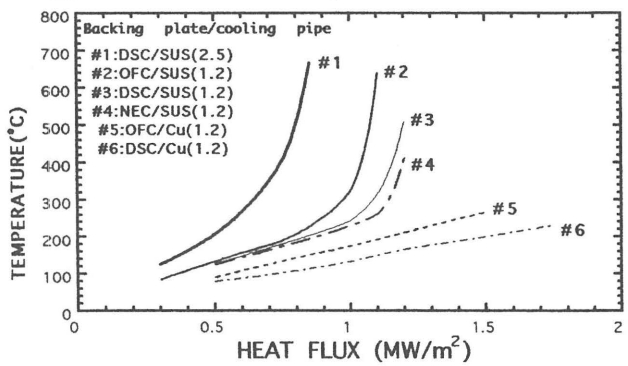

Fig.3 Relationship between the temperatures of the backing plate at the end of heat test and heat fluxes.

Reference

1) Kubota, Y., Noda, N., Sagara, A., et al., NIFS-MEMO-16(1995).